Strategy instruction boosts visual search optimality but such improvements transfer poorly to similar tasks

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Abstract

When searching for a target in a visual environment, such as for a car in a parking lot, performance depends on the search strategy chosen, with suboptimal strategies resulting in longer search response times (Leber & Egeth, 2006a). Strategy choice varies between individuals, and the differences have been found to remain stable over sessions (Irons & Leber, 2016), although we have found that explicit strategy instruction can improve optimal strategy use (Hansen et al., 2019). The present study explores whether such improvements can generalize across separate tasks than retain similar strategy components. We focused on two tasks that show a positive correlation in optimal target choices, the Adaptive Choice Visual Search (Standard ACVS; Irons & Leber, 2016) task and the Adaptive Choice Visual Search Color Cue (ACVS Color Cue; Li et al., 2021). Both tasks were based on subset search, featuring squares of different colors with two targets, either of which was correct. The optimal target was present in the smaller subset, and its identification required enumeration in Standard ACVS and interpretation of a symbolic cue in Color Cue ACVS. Participants completed both tasks in one session, with the order of tasks counterbalanced. The instruction group received explicit strategy instruction in the first task, while the control received no strategy instruction. Results showed a positive correlation between proportion of optimal choices and trial response times between the two tasks suggesting that performance in one could predict performance in the other. Explicit strategy instruction in either task was able to improve optimal strategy use compared to control in the first task, but the instruction group failed to hold on to the improvements when the task was switched. We also found that participants who received instruction in Standard ACVS did hold on to the improvement in Color Cue ACVS, leading us to speculate that instruction may generalize between tasks that share enumeration as a strategy component but differ in others.

Introduction

There are millions of everyday situations where one must search through a given set in order to fulfil some predetermined goal. Attempting to find someone in a crowd, searching for apples in a grocery store, and looking for one's car in a parking lot are all examples that have been commonly used to represent what is essentially a visual search activity. An activity such as any of these can benefit from a plan for how to achieve the goal of the search quickly, and with minimal effort. This plan would have to be prepared and implemented by the searcher, and it would have to be updated pursuant to the conditions of the search activity, if they happen to change. When searching for someone in a crowd, it would be wise to search only through the people as tall as the target, searching for apples in a grocery store shelf can be restricted to items that are red only, and searching for one's car can focus specifically on the vehicles that match the approximate size of the target.

These are examples of using goal-directed attentional control settings, defined as a state of information processing that prioritizes and selects chosen stimuli in the visual environment (Leber & Egeth, 2006a). Studies have consistently found that individuals are capable of using goal-directed control to bias the processing of a desired feature and to ignore irrelevant information in order to improve efficiency (e.g., Folk et al., 1992, Desimone & Duncan, 1995). The deployment of goal-directed attentional control is not uniform among individuals, and there are two major sources of variation: ability and strategy (Irons & Leber, 2018). Continuing with the previous example, let us look at two issues that can arise with our search settings (i.e., attentional control settings); Can the settings be implemented by the user? Secondly, assuming the settings can be implemented, do they provide the user with the most benefit?

Previous work has found significant individual differences among people regarding both these crucial factors. Individuals' ability to ignore salient, irrelevant information comes into play and determines their performance on tasks (Folk et al., 1992; Theeuwes, 1991, 1992). The second source or variation is the quality of the plan itself, or the strategy. There are many studies that show that individuals act as perfect searchers and attempt to maximize performance by selecting the strategy that provides them with the most benefit, or the optimal strategy (Ma et al., 2011; Najemnik & Geisler, 2005; Navalpakkam & Itti, 2007; Scolari & Serences, 2009; Wolfe, 2013). Bacon and Egeth (1994) found, in contrast, that individuals often use suboptimal attentional control settings, which they speculate was due to the possibility that optimal search strategy is cognitively demanding since it requires a top-down focus on the feature or features that collectively make up the target of the search. Maintaining it through the duration of a task also requires monitoring of the search environment for any changes (Braver, 2012; Braver et al., 2007; Chatham et al., 2009; Locke & Braver, 2008), followed by switching, and updating and implementation of newer strategies (Arrington & Logan, 2004; Monsell, 2003), all of which place additional cognitive demands upon individuals. Irons & Leber (2018a) found that part of the blame for suboptimal strategy use can also be placed upon a lack of awareness of what it is. Several studies since then have highlighted suboptimal strategy usage by individuals, that have resulted in longer response times in search tasks, worse accuracies, and a propensity to be distracted by irrelevant information (e.g., Leber & Egeth, 2006a, 2006b; Proulx, 2011; Leber et al., 2009; Kawahara, 2010; Rajsic et al., 2015; Rajsic et al., 2017).

In studies where individuals do not behave as perfect searchers, a wide range of variation in strategy choice within samples has been consistently found by researchers (e.g., Kristjánsson et al., 2014; Boot et al., 2009; Nowakowska et al., 2017; Clarke et al., 2018). Clarke and colleagues (2018) hypothesized that these individual differences would remain stable across tasks. They had participants complete three different visual search tasks, namely the Mouse Click Foraging task (Kristjánsson et al., 2014), the Split Half Line Segment task (Nowakowska et al., 2017) and the Adaptive Choice Visual Search task (Standard ACVS; Irons & Leber, 2016), over multiple sessions. Surprisingly, they found no between-task correlation on the key strategy-related individual differences measures but confirmed that each task displayed high test-retest reliability (Clarke et al., 2018). Essentially, individuals' strategy choices on one task in no way predicted their performance in another. An individual may use an optimal strategy consistently on one task but use an inefficient one on another. It was suggested by the researchers that the tasks they used constituted different strategy contexts, since they required participants to achieve different sub-task goals (Clarke et al., 2018). It would therefore be reasonable to expect strategy generalization between tasks that use similar strategy contexts. Li et al. (2021) attempted to showcase the very same, creating the Color Cue Adaptive Choice Visual Search task (Color Cue ACVS), a variation that they hypothesized matches the strategy context offered by the Standard ACVS task, except that it requires different strategy components. Specifically, while Standard ACVS relies on participants to enumerate the displays to determine the smaller subset, no such enumeration can be performed in Color Cue ACVS to determine the optimal strategy. Rather, strategy in this task can be optimized by interpreting a central display cue.

The Adaptive Choice Visual Search Task

The Adaptive Choice Visual Search Task (Irons & Leber, 2016) is a visual search task developed to study search strategy in individuals. The task features a display (see Fig. 1) that is composed of small squares arranged in three concentric circles around a dot. The squares can be red, blue, or green, and they contain different numbers between 2 and 9. Each trial display features two targets, one red and one blue, each containing a different number between 2 and 5, while all other red and blue squares have a number between 6 and 9. The green squares serve solely as distractors and may contain any number between 2 and 9. The number of green squares is constant across trials, but there are always more squares of one of the target colors. Therefore, the optimal strategy is to search for the target within the color subset that has the fewest squares. The key individual differences measure of interest is the proportion optimal (optimality), or the ratio of trials where optimal strategy was used with the number of correct trials. The color that has fewer squares changes frequently, with runs of 1-6 trials where blue is the optimal color interspersed with runs of 1-6 trials where it is red, necessitating performance and environment monitoring and switching of control settings in order to maximize performance. Even though searching for the optimal target provides a performance benefit, Irons & Leber (2016, 2018) found that individuals display a wide range of search behavior, and that most are nowhere near perfect optimality. The differences were found to remain stable over multiple sessions (Irons & Leber, 2018). The task has been shown to have high internal consistency, and high test-retest reliability (Irons & Leber, 2016, 2018. 2020).

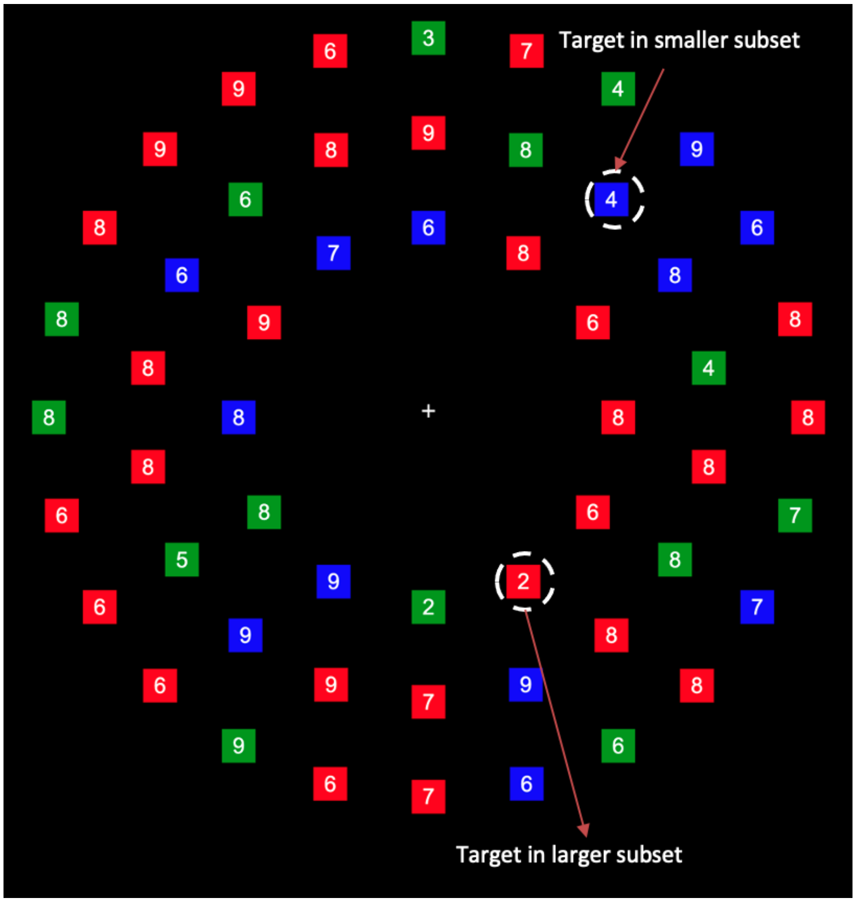


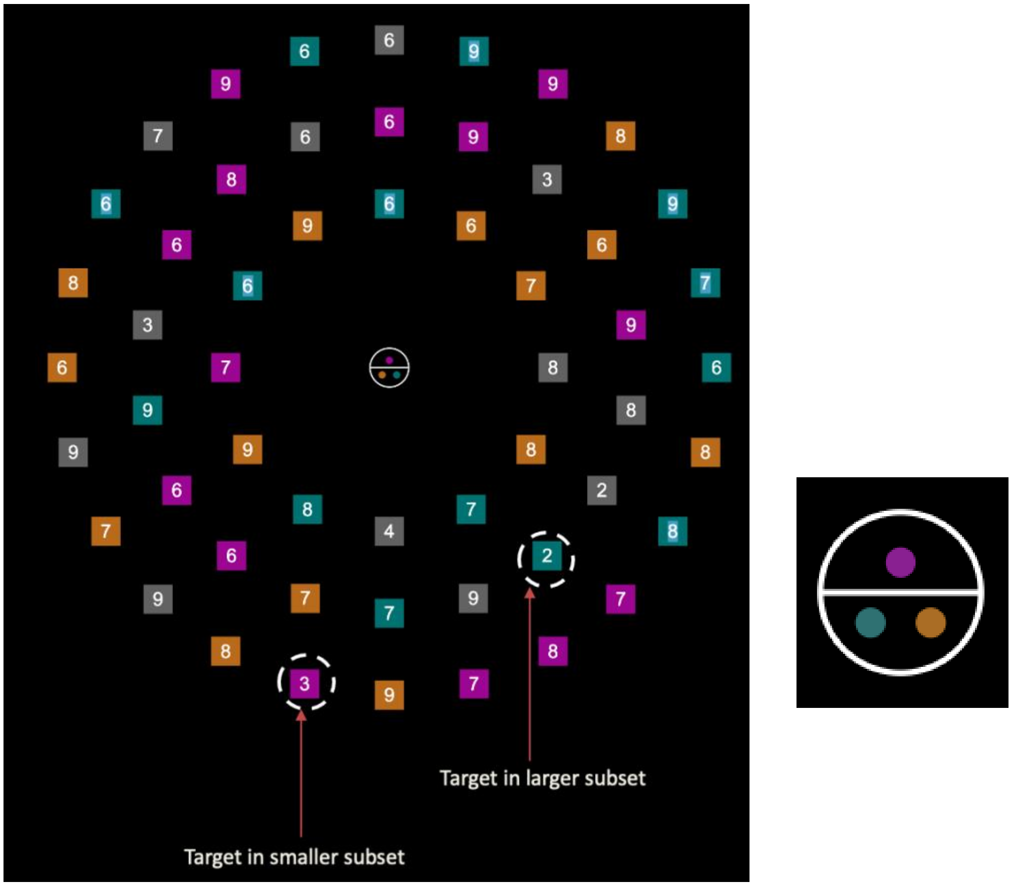
Figure 1: ACVS (Irons & Leber, 2016). The trial display consists of red and blue squares on a black background. There are two targets, one red and one blue square with a number between 2 and 5 superimposed on it. On this trial, there are fewer blue squares, implying that it is the optimal target.

Color Cue Adaptive Choice Visual Search Task

The Color Cue Adaptive Choice Visual Search (Color Cue ACVS; Li et al., 2021) was designed as a variation of the ACVS task. It features a display (see Fig 2A) marked by 54 squares, as in the ACVS task, but there are 14 squares each of magenta, cyan, and orange, along with 12 grey squares. As in Standard ACVS, each square has a number between 2 and 9 superimposed on it, and there are two target squares each containing a different number between

2 and 5. The two targets are each a different color chosen from among magenta, cyan, and orange, and all non-target squares of these colors contain a number between 6 and 9. The grey squares are always distractors and may contain any number between 2 and 9. A circular color cue (see Fig 2B) appears at the center of the screen instead of the fixation cross seen in ACVS. The color cue is subdivided into two halves, one containing a dot that represents the color of one target square, the other half containing two dots, one of which represents the color identity of the other target. Interpretation of the clue, therefore, gives individuals the optimal strategy, since the color of the lone dot in the cue subdivision is the smallest subset an individual can search through for the target. This task has also been shown to have high internal consistency in individual differences measures (Li et al., 2021). Li et al. (2021) found that the two tasks, ACVS and Color Cue ACVS, show significant correlations in two individual differences measures: optimality ($r = 0.334$, $t(48) = 2.458$, $p = 0.0176$) and switch rate ($r = 0.429$, $t(48) = 3.286$, $p = 0.0019$) (Li et al., 2021). The data therefore provide evidence of strategy transfer between the two separate, but related visual search tasks.

A.



B.

Figure 2: A) ACVS Color Cue (Li et al., 2021). Interpretation of the cue would lead to the determination that there is one magenta target and one target among the orange and cyan squares. The optimal strategy is to search for the magenta target. B) The cue, enlarged.

Can we improve strategy use?

It has been shown that attentional control settings are flexible and can be updated based on the demands of a task (Vickery et al., 2005; Lien et al., 2010). It is tempting to infer, therefore, that explicit strategy instruction can affect an individual's strategy choice in visual search tasks, but studies have had different outcomes. Bacon & Egeth (1997) found that individuals are able to modify their strategy based on experimenter instructions, and are able to apply that consistently, ignoring distractors that may be present. Boot et al. (2009) showed that individuals change their strategy when they are provided with explicit feedback, indicating that awareness of inefficient strategy use can result in reconsideration. Contrastingly, Kawahara (2010) instructed a set of participants to use a particular strategy and found that they did not comply with the instructions even though they reported that they did. Proulx (2011) found that attention can still be captured by singletons even after participants are explicitly instructed to ignore them. With regard to ACVS specifically, Irons & Leber (2018b), and Hansen et al. (2019) found that individuals improve their strategy usage if they are told what the most efficient way to do a task is, although both these studies concede that some individuals still choose to use suboptimal strategies post awareness. Overall, these results suggest that instruction can increase awareness of strategy among the participant group, but not all those who are aware will end up actually using it.

The present study

A complete idea of the concept of strategy contexts and subcomponents is quite far away, but this study aims to take a step forward in that direction. Since explicit instruction can lead to increased use of optimal strategies, we hypothesized that the benefit of explicit instruction in one visual search task should generalize, or be carried over, to another task which utilizes a similar strategy context with different strategy subcomponents. A number of convincing theories suggest that transfer of skill between related tasks is a possibility (Taatgen, 2013), but there is a staggering lack of studies that seek to examine transfer of instructional benefits, specifically with regard to visual search strategy. Such a study can have significant implications for the millions of people who must conduct visual search tasks constantly and efficiently (e.g., baggage screeners).

Firstly, we seek to replicate the findings of Li et al. (2021) with regard to the correlations in individual differences measures between ACVS and Color Cue ACVS. We hypothesize that explicit instruction in either search task would lead to a significantly higher use of optimal strategy compared to control in the other task as well. Our individual difference measure of interest is proportion optimal (optimality) of individuals. We expect explicit instruction in optimal strategy to increase optimality in an instruction group compared to a control, in line with Hansen et al. (2019) and Irons & Leber, (2018a), and if the optimality boost transfers into the next phase of the experiment, where the task is changed and no explicit instruction in optimal strategy is provided, it would provide evidence for the generalizability of instruction.

Methods

All methods were approved by an Institutional Review Board (IRB #2020E1288) at the Ohio State University. The experimental hypotheses, methods, sample sizes, collected data, and analysis plans were preregistered (osf.io/rnybz/). We preregistered a sample size of 100 since it gave us a power of 0.90 to find an effect size of 0.655 when comparing the proportion of optimal choices in the second half of the experiment. Any analyses not included in the submitted preregistration are declared as exploratory.

Participants: 116 individuals were recruited via Prolific, a website for those volunteering to participate in behavioral experiments. Participants were compensated with $10.50 per hour to complete the study. All participants had self-reported normal or corrected-to-normal vision, and normal color vision. Data for 14 participants were excluded as their data did not meet the predefined accuracy threshold (greater than 80% overall or within 3 standard deviations of the overall mean). Furthermore, data for 2 participants was lost as a result of a data retrieval error. This gave us a final sample size of 100 individuals (52 male, 40 Female, 3 non-binary, 5 did not report) aged between 18 and 40 (M = 29.41, SD = 6.23). Participants were randomly assigned to one of two groups of 50 participants each, namely Strategy Instruction (SI) group and No Instruction (NI) group.

Apparatus: Participants completed the study in a location of their choice, using their own computer with a physical keyboard.

Stimuli: The experiment was run, and data was received using a PHP program hosted on our laboratory's experiment server. Stimuli were presented using JavaScript. Instructions were presented as jpeg images.

Standard ACVS: The stimuli were based on Irons & Leber (2018, JEP:HPP, Experiment 2). The display contained 54 squares (13 red [RGB: 255 0 0], 13 blue [0 0 255], 14 green [0 255 0], and 14 variably colored). On half the total trials in a block, the variable distractors were blue and on the other half, they were red, with their color staying constant over short runs of 1 to 6 trials, and then changing. The stimuli were displayed in a region of the participants' screen that was 100 units in width and height, utilizing the entire screen except for a 5% vertical buffer zone. The absolute sizes depended on the size of the screen used. The squares were arranged in three concentric circles around a fixation cross at the center of the screen (50 units, 50 units) and the radius of the middle and inner circles were 0.75 and 0.50 times respectively that of the outer circle (45 units). Squares were equidistant from other squares in the circle, had a width and height of 4 units, and contained a white digit at the center sized 65% as large as the square. The two targets digits were randomly picked among the 4 options [2,3,4,5], and were always different numbers and colors. Their positions were also randomly picked but were always at least 30 units away from each other. The other blue and red squares had their positions and digits randomly shuffled on every trial, while each green distractor had a 50% chance of containing a potential target digit. On every trial, the fixation cross appeared at the center of the display first, for 400 ms, followed by a preview of the colored squares without any numbers superimposed on them for 1000 ms, after which the numbers appeared. Hansen et al. (2019) found that such a preview can improve strategy choice in ACVS. The two targets were one red square with a number between 2 and 5, and one blue square with a number between 2 and 5, the two target numbers never being the same. All other blue and red squares had a number between 6 and 9, while green distractor squares could have any number between 2 and 9. Participants responded using the V, B, N, and M keys on their keyboard, each corresponding to a possible target number (2, 3, 4, and 5) respectively.

Color Cue ACVS: The stimuli were based on Li et al. (2021). The display contained 54 squares (14 magenta, 14 cyan, 14 orange, and 12 grey) in the same spatial locations as the ACVS squares. Potential targets could be either magenta [RGB 150 0 0], cyan [RGB 0 115 115] or orange [RGB 179 107 0], with one target of any one of the colors, and another of either of the two colors. Grey [RGB 98 98 98] distractor squares had a 50% chance of containing a potential target number. A circular cue (radius = 1.5 units) appeared at the center of the display in place of the fixation cross of ACVS, for 400 ms, followed by the colored squares without digits superimposed on them for a 1000 ms preview, followed by the digits. Participants responded using the V, B, N, and M keys on their keyboard, each corresponding to a possible target number (2, 3, 4, and 5) respectively.

Procedure: Each experimental run was divided into two phases, depending on which task (ACVS or Color Cue ACVS) was run first. Therefore, the SI and NI groups with N = 50 in each were further subdivided into two groups with 25 participants in each subgroup beginning ACVS in Phase 1 followed by Color Cue ACVS in Phase 2, while the other subgroup began with Color Cue ACVS in Phase 1 followed by ACVS in Phase 2. Each phase consisted of 2 blocks of 84 trials each, making up 164 trials of each task over the course of an experimental run.

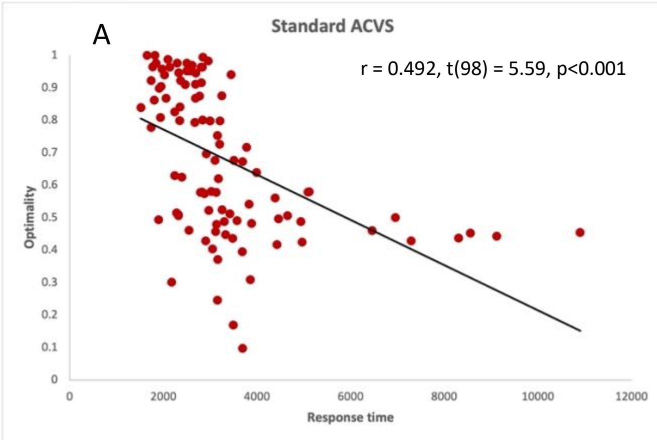
Both the SI and the NI groups received general information at the beginning of each phase, depending on the task they were to complete in that phase. They were shown a sample trial display and informed of what the identity of the targets are on each trial. The Color Cue ACVS task included a description of what the circular cue represents. Participants of both groups then completed 10 practice trials of the task that immediately followed.

The SI group received one slide of strategy instruction following the practice trials of Phase 1. The slide featured an example trial of the task, along with markers indicating the two potential targets labelled “Target in smaller subset” and “Target in larger subset”. Alongside were the words “You may have noticed that each trial has a different number of squares in each color subset. We have found that performance is most efficient if you search for the target in the subset that contains fewer squares.” The instructions were kept consistent regardless of the identity of the first task, with the only change coming in the form of the words “as indicated by the cue” at the end of the first sentence if the first task was Color Cue ACVS. The participants then completed 6 multiple choice questions as a check on their understanding of the strategy. The questions featured a randomly generated trial display as would be seen during the experiment, along with the question: “What is the optimal color to search through to find the target?” A correct response triggered a move to the next question with a new trial display while an incorrect one triggered feedback that asked the participant to try again. After 6 correct responses, the first experimental block of trials began. Self-paced breaks were allowed between each block.

Results

Overall accuracy was high ($M = 97.18\%$, $SD = 3.86\ \%$) and there was no significant difference between the accuracies of both Standard ACVS ($M = 97.42\%$, $SD = 4.80\%$) and Color Cue ACVS ($M = 96.95\%$, $SD = 4.67\%$), ($t(198) = 0.70$, $p = 0.48$). All further analyses excluded incorrect trials, trials in which participants had response times (RTs) less than 300 ms, and trials in which RT was further than three standard deviations of the subject’s overall mean RT.

Mean RT was 3556 ms with a standard deviation was 1774 ms (Standard ACVS: $M = 3284$ ms, $SD = 1619$ ms; Color Cue ACVS: $M= 3844$ ms, $SD = 2093$ ms). Our major individual differences measures of interest showed great variability. Mean optimality for participants ranged from 0.328 to 0.994 ($M = 0.701$, $SD = 0.192$). Frequency of switching ranged from 0.285 to 0.715 ($M = 0.583$, $SD = 0.084$). As expected from previous studies using ACVS, higher optimality was correlated with lower RT in both tasks (Standard ACVS: $r = 0.492$, $t(98) = 5.59$, $p<0.001$; Color Cue ACVS: $r = 0.511$, $t(98) = 5.88$, $p<0.001$), showcasing the performance benefit provided by using the optimal strategy (see Fig 3).



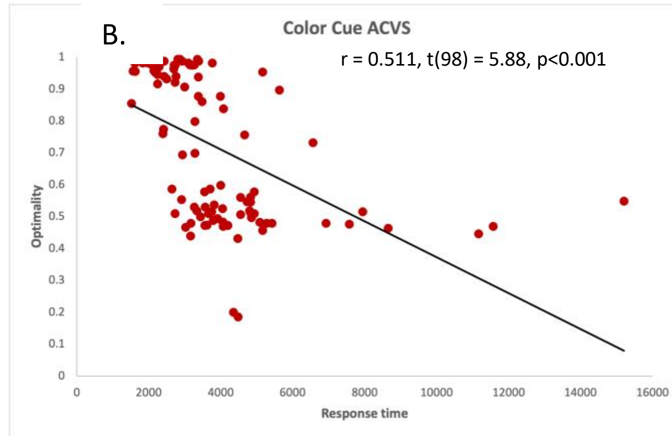


Figure 3: Optimality vs RT correlation analysis A) Standard ACVS and B) Color Cue ACVS

Between task correlation analysis: Correlations were observed in performance and individual differences measures between ACVS and ACVS Color Cue. These analyses involved only those participants in the control (no instruction) group, in order to avoid the potential effects of the instructional manipulation. There were significant positive correlations (see Fig 4) between individuals with regard to optimality ($r = 0.370$, $t(48) = 2.76$, $p < 0.01$) and RT ($r = 0.826$, $t(48) = 10.15$, $p < 0.0001$). We did not find a significant correlation between frequency of switching between the two tasks ($r = 0.117$, $t(48) = 1.225$, $p = 0.226$), likely due to the increased switching required in ACVS Color Cue compared to ACVS, as a result of three potential target colors being available instead of two.

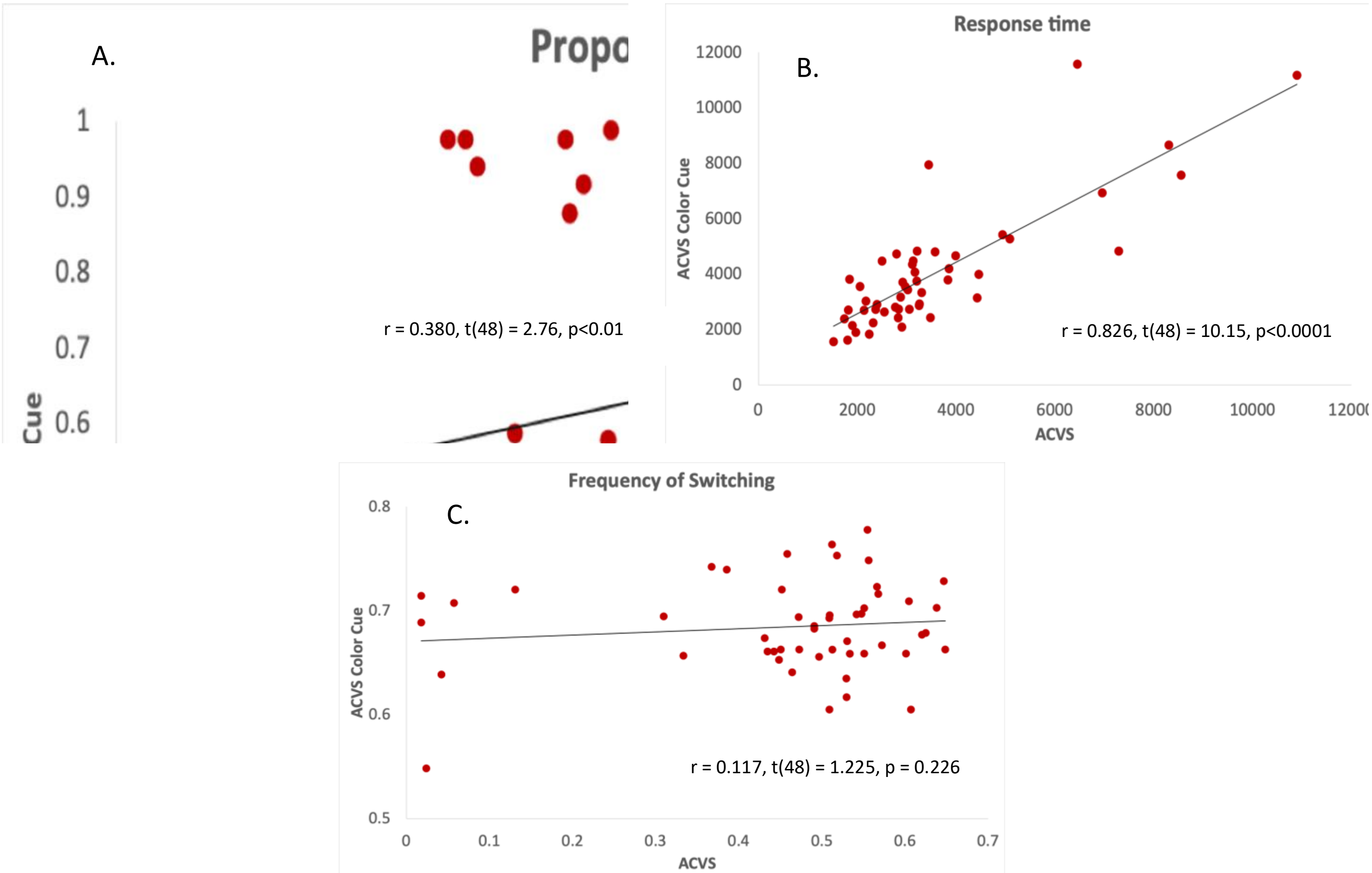


Figure 4: Correlations between major measures of performance, namely A) Proportion optimal, B) Response time, and C) Frequency of switching, between Standard ACVS and ACVS Color Cue

Instructional manipulation: Mean optimality for the SI group in phase 1 was high (M = 0.795, SD = 0.189), while the NI group was lower (M = 0.609, SD 0.203). Phase 2 optimality for the SI group dropped (M = 0.716, SD = 0.252), but rose for the NI group (M = 0.683, SD = 0.237) (See Fig 5). Error bars representing the standard error are shown, their range calculated by dividing the standard deviation by the square root of the number of measurements.

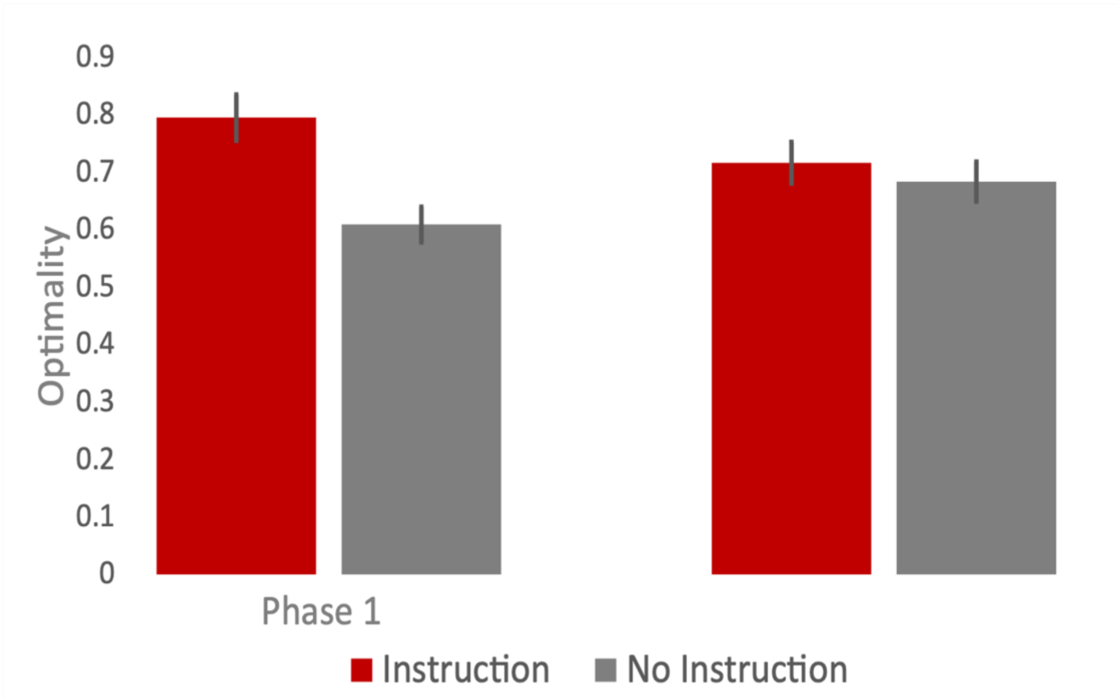


Figure 5: Comparison of mean optimality (Phase 1 and 2) for the SI and NI groups

We conducted a 3-factor mixed ANOVA with 2 between-subject factors, namely instruction (SI or NI) and task order (ACVS first vs ACVS Color Cue first), and 1 within-subject factor, namely phase (phase 1 or 2), with the variable of interest being optimality. The main effect of instruction was found to be significant ($F = 8.939$, $p = 0.004$), while the main effects of task order and phase were not significant. A t-test comparing phase 1 optimality between the SI and NI groups was found to be significant ($t(98) = 4.737$, $p < 0.001$). Our critical analysis comparing the phase 2 optimality means of the SI and NI groups was not significant ($t(98) = 0.667$, $p = 0.506$).

We conducted some exploratory analyses of unexpected results. The mean phase 1 optimality for the SI group that was instructed in ACVS (N = 25) was M = 0.828, SD = 0.175, and it was followed up by a mean phase 2 optimality (in ACVS Color Cue) of M = 0.783, SD =

0.225. Contrastingly, the SI group that began with and received instruction in ACVS Color Cue (N = 25) had a phase 1 optimality of M = 0.761, SD = 0.201 followed by a phase 2 optimality (in ACVS) of M = 0.649, SD = 0.268. We did not perform any significance tests comparing means of these groups since the results of the ANOVA did not justify such post-hoc analysis.

Discussion

Strategy choice in visual search has many implications for visual search performance. The importance of strategy in conjunction with ability has been expounded on in quite a bit of detail in recent studies (e.g., Nowakowska et al., 2017; Irons & Leber, 2020). While individual differences in strategy use have been found to remain constant over multiple sessions in the same visual search tasks, generalizability of strategy has not been observed between tasks (Clarke et al., 2018).

It has been recently shown that strategy can generalize between tasks that offer similar strategy contexts (Li et al., 2021), so we set out to study whether strategy use would be amenable to instruction, and whether the benefits of such instruction would transfer to a separate, but similar, task. Through our experiment, we were able to show correlations in individual difference measures between ACVS and Color Cue ACVS, replicating the results of Li et al., (2021). We were also able to show that explicit instruction leads to a significant increase in proportion of optimal choices compared to a control group, but does not produce perfectly optimal search, solidifying our belief that awareness of the optimal strategy does not guarantee its constant use.

Our central question was whether strategy use generalizes between related tasks, and we were unable to find evidence of such transfer. The strategy instruction group did not maintain their relatively higher optimality through the change in task. The control group's optimality actually shot up in the second phase of the experiment, nearly reaching levels similar to those of the instruction group's in phase 2. Interestingly, participants in the instruction group that were instructed in ACVS maintained high levels of optimality in Phase 2 compared to those who were instructed in ACVS Color Cue.

The existence of generalizability between tasks is of great significance to researchers attempting to study the malleability of cognition and its potential for general improvement. This idea, of 'brain training', has been of interest for long (Thorndike & Woodworth, 1901), but over a century of work has not yielded a comprehensive understanding. Thorndike (1922) showed that there were elements of skill transfer between some tasks that could be considered related. In a seminal study building on Thorndike's work, Singley and Anderson (1985) showed substantial transfer of learned skill using text editors to a different text editor that was similar on a higher level but used different keystrokes. In a controversial study, Jaeggi et al., (2008) showed evidence of 'far transfer' as well, the apparent transfer of cognitive skill between unrelated tasks, but this study has failed replication tests multiple times (Redick et al., 2013). More recent studies seem to agree that there is enough evidence to conclude that training improves performance in the task the training was provided in (Owen et al., 2010, Kramer et al., 2019), but disagree on what the consequences of such an improvement are. Owen et al., (2010) found through an online study of over 11,000 subjects that there is no transfer of training improvement across tasks, related or otherwise, across domains ranging from attention to reasoning and memory. Simons et al. (2016) found some evidence suggesting that there is transfer of trained skill between related tasks but reject the notion that it can have any effect on unrelated tasks or general cognitive ability.

Cognitive performance, though, is heavily dependent on both ability and strategy. Irons & Leber (2020) note that the wide range of individual variation reported in visual search strategy shows indicates that it may play a large role in search performance and is therefore a great target for training, especially since strategies are much more flexible (Irons & Leber, 2020). Strategy is also more relevant in real world tasks in unconstrained environments, contrary to those performed under laboratory conditions. Since most of the previous and contemporary research discussed above has focused on ability measurements rather than those of strategy, research on strategy training is of significant importance.

Based on our results, with specific consideration of the differences in the instruction group's Phase 2 performance observed based on the identity of the Phase 1 task, we speculate a role for strategy subcomponents in the generalizability of instruction. While the overall results indicate that instruction does not generalize between tasks that use similar strategy contexts, the tasks do constitute different strategy subcomponents; ACVS requires enumeration while ACVS Color Cue requires interpretation of the cue at the center of the screen. Therefore, we offer a road for further research. Instruction may generalize between enumeration tasks that differ in a separate strategy subcomponent, or between cue-based tasks that differ in another respect. Additionally, Kramer et al. (2019) speculated that strategy training in visual search is unlikely to generalize unless a significant amount of training over a long period of time is provided, another possible avenue for future studies.

In conclusion, this study shows evidence for the effect of explicit instruction on increasing the proportion of optimal choices in visual search tasks. We were unable to show that instruction generalizes between ACVS and ACVS Color Cue. We suggest that future studies be aimed at narrowing down the factors and subcomponents that play a role in the generalizability of strategy use as well as that of instruction. An understanding of the same may have implications for the training of people's use of goal-directed attentional control.

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